ALPHABET

OF

ROCKS AND MINERALS

BY

MARGARET B. ALDER.

Belfast:
UNIVERSITY BOOK-PRINTING HOUSE,
(Allen, Son & Allen)
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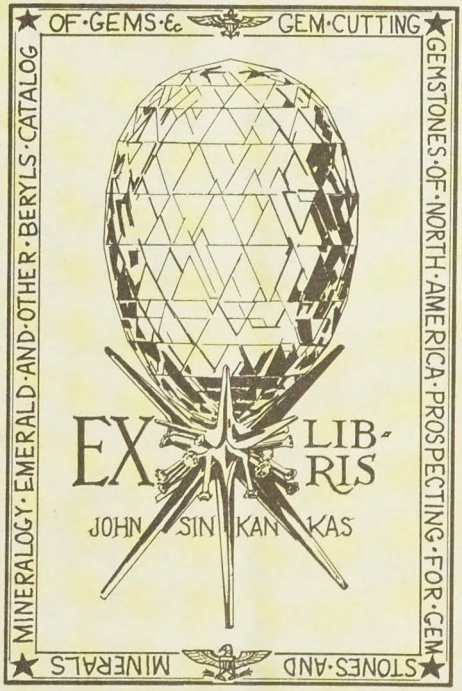
1888.


OF·GEMS·&c GEM·CUTTING
GEMSTONES·OF·NORTH·AMERICA·PROSPECTING·FOR·GEM
STONES·AND MINERALS
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PREFACE.

IN this little Brochure no attempt is made to enter into the chemical quantities of the material of minerals, but the purpose is to give a rough statement of the Elements which constitute the commoner rocks and minerals of the earth, and to advance the theory that the materials of the crust of the earth have not resulted directly from "*fusion.*" The quantities given of each element are only approximate. The symbols of the Elements are made to stand for their oxides—as, Si. for *Silica*, and Al. for *Alumina*, t stands for a trace, when the proper quantity is not stated.

The Elements, of which about 75 are now known to chemists, are indeed *The Alphabet of Nature:* Nothing which we see, taste, or touch, but is composed of their atoms, even our own bodies become separated into them when life departs! The combination of the Elements is a study essential to Chemistry, and also to Mineralogy and Geology.

By the study of the Elements, their crystallizations and their transformations, we not only learn something of Matter but of Motion, for it is evident that the different forces by which atoms of matter are drawn towards each

other, or to the earth, gravity, natural affinity, or elective affinity, *are one and the same thing*, and form the keystone to the arch of Knowledge.

Every atom may be looked on as a minute, indivisible body, so small that no miscroscope can present it to human vision, and each element has atoms differing in size, shape and quality, from every other element. We cannot for a moment suppose that atoms can move of themselves. Indeed *dead matter* is the true and ancient phrase which expresses this ; but when atoms are disturbed (perhaps by light, or heat, or the mysterious force of attraction, *which we must allow exists*), they naturally fall back into their former equilibrium, and it is wonderful how each atom assorts itself into geometrical order, *to form crystals* in perfectly straight lines and curves, with the other atoms related to it, but this is as surely an effect of gravitation as the falling of a stone to the earth.

Many persons have attempted to classify the Elements, but even the classification of the celebrated Mendelèeff is not altogether satisfactory. A classification which merely assists the memory is given here.

It is easy to see that if we could raise the temperature sufficiently high, all the Elements would become gaseous, and if it was lowered exceedingly, all the Elements could be rendered solid, or even metallic, as Ms. Cailletet and Pictet have proved, since by *cold and pressure* they have solidified oxygen, carbonic acid, nitrogen, &c.

One leading thought guides the learner to grasp

the truths of Mineralogy. It may be thus commonly stated, that all minerals are only *rusts* of *metals*, or more properly speaking, a gasecus element and a metallic element unite to form solids; thus copper and sulphur unite to form crystals of *blue vitriol*, or *chlorine* (*a gas*) *and sodium* (a metal) *unite to form common salt.* Silicium (or silicon) forms *silica* or quartz, with oxygen gas, and so on. Sometimes two solid elements unite to form salts or crystals, such as iron and sulphur making iron pyrites. It seems that two metallic elements seldom directly unite, but that they require a gaseous element to *cement them as it were.* Silicon does not form silicates, with aluminum, without having *oxygen* to assimilate them, and so with many other metals. Sulphur rusts, or corrodes metals, of itself; so does hydrogen; and we all know two gases will form a liquid such as water. Chlorine alone affects gold, and fluorine corrodes glass.

Most minerals are found crystallising out of lime—great masses of granite and of basalt have this origin. Serpentine, augite, mica, felspar, clearly accumulate from the iron, the alumina, the magnesia, and potash, originally disseminated through oxide of lime, mixed with silica; the body of the strata of lime changing to carbonate, the chemical heat generated in the process being sufficient to bring about further change. The heat of the sun stored yearly in the crust of the earth, and the vast pressure of the surface strata and of the atmosphere producing the increasing heat met with in mines. Of course this heat cannot go on increasing in the ratio we find it, or the ground would

melt under our feet. It must be met by cold internal waters, and masses of unoxidised elements.

The manner in which *flint*, and in Ireland, *lydian stone*, aggregate in layers in limestone rocks, is a process very familiar. No doubt the materials of these rocks were disseminated through each other under water. So with isopyre, tachylite, and obsidian — the latter is found altered by volcanic heat. The metallic elements once distributed through clay, sand, and lime soon become chemically united with them, and are the origin of such rocks as labradorite, gabro, serpentine, mica schist, granite, hornblende, &c.

Bombs of granite have lately been found in Ireland, accretions of such minerals as crystallise in radiated masses, and they are no more volcanic than basaltic bombs, found at the Giants' Causeway, the Eifel on the Rhine, and elsewhere.

LIST OF ELEMENTS AND SYMBOLS.

Name.	Symbol	Name.	Symbol	Name.	Symbol
Aluminum,	Al.	Gold,	Au.	Platinum,	Pl.
Antimony,	Sb.	Hydrogen,	H.	Potassium,	K.
Arsenic,	As.	Ilmenium,	Il.	Rhodium,	R.
Barium,	Ba.	Iodine,	I.	Ruthenium,	Ru.
Bismuth,	Bi.	Iridium,	Ir.	Selenium,	Se.
Boron,	B.	Iron,	Fe.	Silicon,	Si.
Bromine,	Br.	Lanthanum,	La.	Silver,	Ag.
Cadmium,	Cd.	Lead,	Pb.	Sodium,	Na.
Calcium,	Ca.	Lithium,	L.	Strontium,	Sr.
Carbon,	C.	Magnesium,	Mg.	Sulphur,	S.
Cerium,	Ce.	Manganese,	Mn.	Tellurium,	Te.
Chlorine	Cl.	Mercury,	Hg.	Terbium,	Tb.
Chromium,	Cr.	Molybdenum	Mb.	Thorium,	Th.
Cobalt,	Co.	Nickel,	Ni.	Tin,	Sn.
Columbium,	Ta.	Niobium,	Nb.	Titanium,	Ti.
Copper,	Cu.	Nitrogen,	N.	Tungsten,	W.
Didymium,	D.	Osmium,	Os.	Uranium,	U.
Donarium,	Do.	Oxygen,	O.	Vanadium,	V.
Erbium,	Er.	Palladium,	Pd.	Yttrium,	Y.
Fluorine,	F.	Pelopium,	Pe.	Zinc,	Zn.
Glucinum,	G.	Phosphorus,	P.	Zirconium,	Zr.

NEW ELEMENTS.

Name.	Symbol	Name.	Symbol	Name.	Symbol
Samarium,	Sm.	Norwegium,		Berylium, or Glucinum,	Be.
Holmium,		Gallium,			
Thullium,		Didymium,			

TABLE OF TYPICAL MINERALS

IN WHICH SILICA PREPONDERATES, THE CONSTITUENTS ARE APPROXIMATELY STATED.

SILICON SERIES.

	Si.	Al.		Iron.
Quartz *proper*, Irish Diamond,	99.	1		
Emerald, Beryl, Aqua-marine (Chromic Oxide),	68	15	Gl.	1
Cairngorm, Smoky Quartz, Avanturine, Cornelian .	84.	16.	Ca.	1
Tourmaline (Schorl) Boracic Acid 4, Mag. 6	36.	35.		10.
Chalcedony, Onyx, Chrysoprase, Cashalong, Jasper,	84	16		1.
Flint, Chert, Hornstone, Lydian Stone, Mag.	74	16		
Tachylite or Bottleite, Mag. Potash, Soda	55.	12.	Ca.	13.
Obsidian, contains Carburetted Hydrogen, Soda, Potash, Water, ... Mag.	75	15	Ca.	4
Isopyre, ... Copper	47	13.	Ca.	20
Pearlstone, Pitchstone, Petrosilex, small portion of Soda, Potash, ... Mag.	75	15	Ca.	1
Mellite or Honeystone is a remarkable substance, containing Hydrogen, Oxygen, Alumina and Carbon,				
Mountain Soap (like Obsidian) black, Lime and Water	44	26		8
Asbestos or Amianthus, *fibrous*, Silicon, Lime 14, ... Mag. 27	55		1	12
Krocidolite, or Crocidolite, *Grey Asbestos*, called from "a flock of sheep." It is like wool, Lime and Magnesia	55	1		12
Pumice, ... Soda 3	77	18		2.

MAGNESIUM SERIES,

In which Silica still predominates, but Alumina is largely replaced by Magnesia, Lime and Iron.

Meerschaum (Spongy carb. of Magnesia) 28 Mag.	55	1	1	1
Palagonite, ... t Soda and Potash 6 Mag.	40	10	8	13
Talc Glimmer ... ... 33 Mag.	58	1		4
Biotite, Phlogopite (Copper Mica), *Lithia*. Li; Mica, ... Mag. 16	42	12	Man.	10

	Si.	Al.		Fe.
Mica *Monoaxial*, Magnesia Mica 20 Mag.	46.	14	.	20
Mica diaxial (Granite Mica), Muscovy Glass Lithia, ... and Mag.	47	20	Man.	15
Brucite is Hydrate of Magnesia,				
Steatite (Talc) Soapstone, Potstone, 32. Mag.	59	32		2
Serpentine (Picrolite), Connemara Marble, Mag. 37	43	1	Ca.	13
Chlorite (Talc Slate), *Alum* 18 ... 12 Mag.	52	10	t.	13.
Chorotoid (Masonite) Iron Felspar 4 Mag.	27.	35	Man.	27.
Olivine, Peridot, weathers into Serpentine, and Augite and Limonite. ... 38 Mag.	50	.	t.	12.
Chrysolite in Basalt (Trap), and Dolorite, same as Olivine, ... 70 Mag.	38	.	t.	.11
Slate, Bole, Lithomarge ... ... 2 Mag.	75	10	t.	3.
Nephrite, Sanssurite (Jade), Fluoric A. 3 Mag.	50.	31.	Ca.	6
In the following Minerals Lime is associated with more marked increase, Silica still prevailing—			Ca.	
Augite (Pyroxene), Iron and Silica (Basalt), 8 Mag.	53.	.	22.	17.
Coccolite (Diallage), Green Diopside, like Olivine, ... t Mag.	48.	2	25.	15
Amphibole, Green Felspar (Byssolite), with Pyrites,	60			2
Actinolite, like Epidote, Lime 14, 21 Mag.	59.	Fe.5	.	3
Epidote (Pistacite) oilgreen to black, Mag. and Water	39.	98	15	8.
Zoisite, ... Ca. 24	40.	30.	t.	2.
Hornblende, like Enstatite ... ... 20 Mag.	59	.	14	7.
Meionite, Scapolite (Wernerite), amorphous,	41.	33	20	
Idocrase, Vesuvian, Pyramidal Garnate, Soda 4	40.	33.	22.	5
Labradorite, Lime Felspar, Amphibole,	56.	27.	11.	.
Iolite (Cordierite Dichroite), green like Hornblende, ... 10 Mag.	48.	31.	1.	9.
Bronzite (Gieseckite Enstatite) in Meteoric Stones & in Olivine Bombs *Eifel.* Mag.	60	5	2	14
FELSPARS.				
Soda Felspar, *Albite*, a portion of the Soda is sometimes replaced by Lime, Potash,	Si.	Al.	Na.	I
Pericline, Avanturine, in the Granite of Mourne, *Mournite*	68	19.	11	1
Potash Felspar *Orthoclase*, Adularia, Sanidine, (in Granite) Common Felspar, or Pegmatite, Ice Spar, Murchisonite,			K	
Lime and Na. Mag.	65	18.	14	1

	Si.	Al.		Fe.
Oliogclase, Moonstone, (in Diorite and Diabase) green or flesh or reddish, Lime and Mag. Potash 2,	63.	23	Na. 7. Na 11	1 1
Microcline, Green Felspar Amazon Stone, Perthite,	68	19	C 18	1
Anorthite, Christianite, Indianite, a lime Felspar in limestone blocks, with Labradorite, Mag. and Na.	43.	35.		
Andesine forms rock masses in Canada, Lime and Soda,	59.	25	6	1
Tridymite or Silicon Dioxide (in Trachyte), said to be found in Meteorites—Asmanite	Si. O2			

Hydrous Silicates, Silica still prevailing but Potassium or Sodium or Calcium largely present, called Zeolites,	Si.	Al.	Na.	
Natrolite Mesotype (Soda), water 45,	47.	26.	16.	
Solicite Mesotype (Lime) *Antrimolite* water,	45	26	14.	
Thomsonite or Comptonite, Lime 12,	38.	31.	4	
Picrothomsonite with Mag. is found in Serpentine Analcime, Potash and water, sometimes transformed into Orthoclase and the Magnesian var. Serpentine is Picronalcime,	55.	23.	12	t
Harmatome is much the same with *Barytes* added,	.	.	.	
Stilbite, Heulandite, Epistilbite &c., are of this class,				
Leucite (Amphigine) the Mineral from which Potassium was first extracted,	54.	23.	K 21.	
Sodalite, green or blue, Chl. Soda,	37.	31.	.	
Nepheline, No. 16,	43.	32.	7.	t
Garnet, *Granat*, Pyrope, Mag. Man.	41.	22.	I. 12.	Ca. 5.
Of very various composition, Iron and Chrome being the colouring matters, Melanite is black,				
	Si.	Al.	Fe.	Li.
Lepidolite (Lithia Mica) lilac 9 K. Man. & fluoric A.	44	24.	4	11.
Autunite (Uran Mica) 61. Oxide of Uranium P.	2.	Ma.	S5.	1
Margarite (Pearl Mica), ... t Lime & Man.	33	58	Mag.	1

ALUMINUM SERIES

IN WHICH AL. IS MORE LARGELY PRESENT	Al.	Si	Fl.	I.
Topaz,	51.	38	17.	

	Si.	Al.		Fe.
Corundum, Adamantine Spar,	98.	6.		2
Sapphire,	90.	7.		1.
Ruby (Spinel), ... t Lime, 8 Mag.	78.	15.		3
Andalusite, ... t Lime, Man. & Potash	60.	36.		4
Emery,	86.	30.		4
Staurolite,	52.	30.		18.
Bauxite, with Iron Ore in Basalt, amophous	64.			52.
These all crystallize out of Aluminous rocks				
CALCIUM SERIES.	Ca.			
Calcite, Carbonate of Lime,... Carbonic A.	55.	Mag.		1
Magnesite, ... C. A 51.		47.		
Yttrocerite, ... 9 Yttria	47.			
Fluor Spar, ... 48 Fluorine	51.			
	Ca.	Mag.		
Gypsum, Alabaster, Selenite, Sulphuric A.	33.			
Dolomite, Bitter Spar, ... 83 Carbonic A.	30.	21.		
Arragonite same as Calcite,				
Malachite, ... C. A. 19. Copper				
Amblygonite, ... P. Al. Li. Na.	2			
Apatite, ...P. 40	48			
There is Fluor Apatite & Chlorine Apatite.				
BARIUM.	Ba			
Baryta, Heavy Spar, ... Sulphuric A.	65.			
Bologna Stone,				
STRONTIUM.				
Celestine, ... Sulphuric A.	St.			
Strontianite.... ... ... C. A. Ca. 4.	70.			
IRON.	Fe.			
Magnetite, Loadstone,				
Martite all mixtures of Iron, Silica, Mag. Ti.	Fe O.			
Mica schist, ... uncrytallized Granite				
Gabbro, ... Mixture of Iron, Silica				
Duffrenite, ... P. & Iron like Hornblende				
Enstatite, Silica & Iron called Hornblende				
Stilpnomelane, P. Ca.	Fe.O	Al.	Mag.	
Iron Silicate.				

	Si.	Al.		Fe.
Chromic Iron.				
Red Hematite.				
ZIRCONIA.	Zr.	Si.		
Zircon. A Zircon Amphibole.				
ZINC.	Zc			
Zincite, ... Isometric.		Si		
Willemite, ... ,,			Mn.	
Franklinite, ... ,,				
OXYGEN WITH VARIOUS ELEMENTS.				
	Man.	O.		
Manganese, Grey Oxide of (*Manganite*).	62	27		
	S.b.			
Antimony, *Antimonial Ochre*, t. Arsenic.	75	19		
Iridium, Oxide of, with Iron and Man *Irite*.				
	As			
Arsenic, Oxide of, *Arsenite*.	75	24		
Titanium, Ilmenite, Titanic Acid Mang.		59.		
Tin, Oxide of Tin Cassiterite.				
	P.b.			
Copper, Red Oxide of Copper *Cuprite*.				
	P.b.			
Lead, Minium Red Oxide of Lead.	90	9.		

Zinc, Spartalite Red Oxide of Zinc.
Iron, Oxide of
Barium, Baryta, Oxide of B.
Oxides of Elements
Uranium, Oxide of, Pechuran Pitchblende.
Cobalt, Black Oxide of, *Arbolane.*
Tungsten, Oxide of, *Wolframocher.*
Titanium, Oxide of, *Rutile.*
Tantalum, (*Columbite*).
Samarium, *Samarskite.*
Niobium, *Niobite*, *Toirelite.*
Vanadium, *Vanadinite* with Lead.
Molybdenum, Oxide of Molybdenum.
Elements, Chromates, &c.

Chromium, *Chromite*, Chromate of Iron.
Boron, *Tassoline*, Native Boracic Acid.
Carbon, *Sabite*, C. of Silver.
Carbon, *Calamine*, C. of Zinc.
Carbon, *Cerrusite*, C. of Lead.
Cerium, C. of, *Lanthamite.*
Lanthanum, C. of, *Parasite.*
Didymium, C. of, *Parasite.*
Yttrium, *Yttrocerite*, contains Fluorine, Calcium;
Cerite, Yttrium, Lanthanum, Didymium, Erbium, a rare Mineral Violet Blue, from America.

Bromargyrite or Bromide of Silver is an Olive Green Mineral.
Iodide of Silver, or Iodargyrite, is yellow.
Chloride of Silver is Embollite, or Kerargyrite.

Malachite is Oxide of, Copper E.

Emerald Nickel is C. of, Nickel E.

Polycrase contains Niobium E.

Thorite contains Thorium E.

Tellurium (foliated or black), *Elasmore* lead and copper with it.

Selenium with lead and copper, *Zorgite.*

Antimony Glauce or *Stibnite* with Sulphur.

Arsenic and Sulphur, *Realgar.*

Arsenic, &c., *Orpiment.*

Lead and Sulphur, *Galena.*

Mercury and S., *Cinnabar.*

Cadmium with Sulphur, *Greenochite.*

Zinc and S. *Blende*, Blackjack.

Cobalt Sulphide or *Jeyporite.*

Lead Graphite, *Plumbago.*

Bismuth with Sulphur, Tellurium, &c.

Osmiridium, Sisserskite (Oxide).

Palladium, whiter than Platinum, bluer than Silicon, absorbs Hydrogen.

Platinum.

Iridium.

Gold—no mineral compounds, cannot be oxidised.

The newly discovered Elements are Gallium, Norwegium, Samarium, and Berylium (which is Glucinum) *Be.*

The Nitrates of Barium, Strontium and Lead, which do not occur as natural minerals, form a remarkable isomorphous group, crystalising in the cubic system.

Diamond is supposed to be only Carbon.

Alum is composed of Sulphuric A., Alumina, Potash and water, it is found in Alum Slate rocks.

Aluminum, is remarkable for its low specific gravity, occurs abundantly in nature in the state of Silicate, as Felspar, &c., Al. forms only one class of compounds, the Chloride is Al.$'''$ 2 Cl. 6, the

Oxide is Al.$^{///}$2 O. 3, it thus resembles the Ferric and Chromic compounds, Al. Chloride is a transparent waxy substance, it dissolves readily in water.

Al. Oxide or *Alumina* (clay) is a sesquioxide, isomorphous with Ferric Oxide, there are Caesium Alum, and Rubidium Alum, which resemble Potassium Alum, and there is Silver Alum, and Thallium Alum, and these are isomorphous with those, in which the trivalent Al. is replaced by trivalent Iron, Chromium and Manganese, so that *Iron and Al.* are nearly related, *and the rusts of these two elements and of Silicon form the great masses of the rocks and earths of the globe, clay, sand, basalt, and granite.*

Silicic Acid, or Silica Si. O. 2, 28 parts S., 32 parts O., is the only known oxide of Silicon (or Silicium), S. Hydride, or *silicated Hydrogen, is a colourless gas*, it contains 28 parts S. to 4 of Hydrogen, there are also Si. Chloride, Si. Tetrabromide, and Si Fluoride. The latter is a permanent colourless gas, very heavy.

Potassium Hydrate is a white solid substance, obtained by decomposing P. Carbonate with slaked lime, the formation of granite is connected with it.

MARGARET B. ALDER,
Holywood, Co. Down, Ireland,
June, 1888.

CLASSIFICATION OF THE ELEMENTS.

(IN GROUPS.)

(The ore or substance from which each can be obtained is mentioned in brackets.)

1. Hydrogen (Water). The lightest gas or substance in Nature. In measuring comparatively the weight of the atoms of matter it is taken as 1.

It is supposed to constitute the fuel of the sun ; it has never been liquefied. Hydrogen burns with a blue flame, giving out little light but *great heat;* during its inflamed condition, it combines with the oxygen contained in the air, and water is formed, which is called *hydric oxide.* Hydric *peroxide* is another description of water, and it has a metallic taste.

2. Oxygen (Air, Water, Rusts). Ozone is an allotropic state of oxygen. This gas readily unites with the metallic elements, especially if they are heated. Gold cannot be oxidised (*or rusted*) either cold or hot. The oxide of hydrogen (water) cannot be formed unless the hydrogen is heated. If oxygen and hydrogen are simply mixed they remain in a gaseous state, but if the hydrogen *is fired,* either by an electric spark or a hot metal, water is instantaneously formed with a loud explosion.

3. Nitrogen (Ammonium, Hartshorn, Fleshmeat). Azote is another name for it: it is allied to phosphorus. With hydrogen it forms a substance like a metal (ammonium). Nitrogen has no taste, no smell, no colour, it neither burns nor supports combustion (that is at common temperatures). The atmosphere is partly composed of it ; it helps to dilute the oxygen of the air, which otherwise would destroy animal life. The gases of the atmosphere are not combined, they are only commingled. Nitrogen combines directly with boron and titanium.

4. Fluorine (Fluor Spar). This gas has never been insulated; *it has a great affinity for silicon*, it forms *no compound with oxygen;* differing in this respect from *all the other elements.*

5. Chlorine (from the Sea, Salt, &c.). It is a yellowish green gas; it becomes liquid at ordinary temperatures under pressure; it unites readily with *all* the other elements; the less oxidable metals, as gold and platinum, are dissolved through its agency. Its bleaching properties are well known. It resembles nitrogen in some respects. *Hydrochloric* acid used to be called muriatic acid, and has "the smell of the sea." Its intense affinity for hydrogen and its corresponding indifference to carbon are remarkable.

6. Iodine (Kelp, Seaweed). Iodine can be procured as crystalline scales of a bluish black colour and metallic lustre; *its vapour appears of a splendid violet colour*, used to cure goitre and other swellings.

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7. Bromine (Sea-water and Saline Springs). A dark brown liquid with a red tint. It has a strong smell. *It forms a red crystalline solid, somewhat metal like*, at a low temperature. It has the same strong affinity for the metals and for hydrogen as chlorine.

8. Phosphorus (Bones and the Phosphates of metals) is allotropic. At the usual temperature it is a *soft*, translucent *solid* of a light amber colour. It may be obtained in dodekahedral crystals. It takes fire in the air which causes it to be luminous in the dark. Red amorphous phosphorus *is a hard brittle substance.* Hydric phosphate is analogous to ammonia; it resembles potassium more than any other element.

9. Sulphur (found native and in ores). Faraday says:—"*It is the very foundation on which chemical manufacture is built up, its relations and combinations are so numerous.* The compounds of sulphur very much resemble those of oxygen. The sulphates

were formerly called vitriols from their glassy appearance, such as blue stone, and it has some likeness to boron and calcium. It is allotropic; appearing as a clear liquid of an amber colour, which thickens, and on raising its temperature becomes a reddish solid, which on cooling may be drawn into threads. Copperas or green vitriol is sulphur with oxygen.

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10. Selenium (found in ores with Tellurium, Silver, &c.). It exhibits great variety in its physical characters; when cool it exhibits a deep reddish surface polished, with a metallic lustre; after fusion it resembles exactly cobalt, fine grained and of a leaden grey colour; it may be drawn out like sealing-wax into thin flexible threads, which are grey and metallic, but transparent and of a ruby red colour by transmitted light. Its vapour is like that of sulphur, *yellow*, and more intense than chlorine; it has a powerful smell like horse-radish.

11. Tellurium (in ores with Gold and Silver). White, brittle, and as fusible as antimony, very brilliant, very crystallizable; assuming a rhombohedral form, in which it is isomorphous with arsenic and antimony.

12. Thallium (from Iron Pyrites). It is a very soft, brilliant white metal, much resembling lead in physical properties, such as density, melting, point, &c. It tarnishes rapidly in air. In chemical properties it is intermediate between the alkali-metals and gold, &c. It forms two series of salts. It was discovered by spectrum analysis; it forms in the spectra a single green ray. Thallium compounds are very poisonous.

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13. Cæsium (Pollux). The most energetic of all metals in chemical affinity—inflames on touching water. Discovered by spectrum analysis.

14. Rubidium (Lepidolite, a variety of Mica) inflames on touching water, like Potassium.

15. Indium, *obscure*, inflames on touching water. Discovered by spectrum analysis.

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16. Potassium (Potash and Leucite). Its appearance is that of black lead (plumbago), so soft that it may be cut with a knife. On touching water it inflames. It cannot be kept in air. Very pure, it has a white colour tinged with blue. It is lighter than water, and swims about on it as it burns with a purple flame. It is the chief of the alkalies. Its uses in the manufacture of soap are well known; and as saltpetre it forms gunpowder with charcoal and sulphur. It crystallizes in cubes. When distilled it forms a green vapour. It has the greatest affinity of all metals for oxygen.

17. Sodium (Salt, Soda). A white metal like silver, so soft it may be moulded by the hand. It oxidates in the air, but not so quickly as potassium. As *potassium is the alkali of the vegetable kingdom*, so *sodium is the alkaline metal of the animal kingdom*, being found in all animal fluids. *Alkaline silicates cannot be obtained by fusion, which are certainly definite combinations, but definite silicates of soda and potash, &c., are found in nature.* The alkaline artificial silicates (glass, &c.) never exhibit a crystalline structure, but are uniformly vitreous.

18. Barium (Barytes or Heavy Spar). A white metal fusible under a red heat. It oxidates with vivacity in water. The atomic weight of strontium is almost exactly a mean between the atomic weights of calcium and barium.

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19. Calcium (Lime, Chalk, Marble). A yellowish white or bronze coloured metal, bright, ductile, somewhat like sulphur and phosphorus in its combinations. It is intermediate in hardness between lead and gold. It decomposes water rapidly.

20. Strontium (Strontia, Celestine). A white metal not so brilliant as barium. It oxidizes in the air, and decomposes

water. It derives its name from Strontian in Argyleshire. It is used, combined with nitrogen, in fireworks to form red-fire; some chemists say its appearance is like gold.

21. Lithium (Spodumene or lithia-felspar and Lepidolite or lithia-mica). *It is the lightest metal known.* It quickly oxidizes in the air, and decomposes water, but not with such violence as potassium or sodium. The vapours of its compounds burn with a bright crimson flame.

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22. Magnesium (Magnesia). Talc, serpentine, pyroxene, chlorite, soap stone, pot-stone, hornblende, and augite contain magnesium. In some of its properties it resembles barium, strontium, and calcium; in others zinc and cadmium. It is a silver white metal, malleable and ductile; it soon tarnishes in the air, but scarcely decomposes water at ordinary temperatures. The light which it emits is very bright and rich in chemical rays, it is known as the magnesium light, but never came into general use. Magnesic oxide is the only known combination of magnesium and oxygen.

23. Aluminum (Clay, Sapphire, Emery, Felspar). Its properties place it next to magnesium, but in appearance it closely resembles Silver, and in France is now largely procured from the mineral *bauxite*, and made into spoons, watch-cases, &c. It is white with a bluish tinge, and is not liable to tarnish even in moist air. It is one-third lighter than silver. It possesses great sonorous properties owing to its compactness. Alum is one of its salts. The silicates of lime and of *alumina* form *zeolites*. One called stibilite is identical in composition with felspar, but contains in addition 6 atoms of water.

24. Glucinum (Beryl, Emerald). A white, light, tasteless metal; infusible, insoluble; its salts have a sweetish taste, hence its name. With silica and alumina it forms aqua marine, emerald, enclase, chrysoberyl, emerald &c. The colouring of the

emerald results from a slight admixture of chrome. Glucinum is fusible with great difficulty, not oxidable by air or water at the usual temperature, but takes fire in oxygen at a red heat, and burns with a vivid light

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25. Mercury (native as Quicksilver, Cinnabar). *Calomel* is the sub-chloride of mercury. Chloride of mercury is *corrosive sublimate*. *Red precipitate* is oxide of mercury, *Cinnabar* or Sulphuret of mercury sometimes occurs as a beautiful crystallized substance, vermillion.

26. Silver (native and in ores with Sulphur, &c.). This element needs no description. It crystallizes in the cube and regular octohedron. It absorbs oxygen when in a melted state and gives it out on cooling. This metal is precipatated by mercury and all the more oxidable metals. Oxide of silver is a powerful base, and forms salts, several of which are found to be isomorphous with the corresponding salts of soda. Nitrate of silver is the *lunar caustic* of physicians. Native silver is always associated with gold.

27. Cobalt (Arsenical Cobalt). Its name is taken from kobolds, the evil spirits of the mountains, as its ores often deceive the superstitious miners. When pure it is *not* magnetic. It is a brittle metal of a reddish grey colour.

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28. Arsenic (in ores with Cobalt and Nickel, in Orpiment and sometimes native). A metal of a steel grey colour and bright metallic lustre, isomorphous with tellurium and antimony. Arsenic vapour is colourless, and like phosphorus and oxygen its combining measure is one volume. Its odour is as strong as that of selenium and resembles garlic.

29. Osmium (in ores of Platinum). A white metal; takes fire in the air, but after being exposed to a red heat osmium becomes

much less combustible and is not oxidated by the humid way, resembling silicon and titanium in that respect. Osmic acid is very volatile, and its odour acid and penetrating, resembling that of chloride of sulphur. From this strong odour it is named osmium. It unites readily with sulphur.

30. Bismuth (native and in ores with sulphur). It is a crystalline brittle metal, having a distinct shade of red. It melts and expands considerably at its solidifying point like water; this property is communicated to its alloys, the most remarkable of which is "fusible metal," 2 parts bismuth, 1 of lead, and 1 of tin; a bar of it will melt in boiling water. Cadmium increases its fusibility. Bismuth is a remarkably diamagnetic metal, repelling the magnet.

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31. Antimony (Sulphuret of Antimony). A white and brilliant metal, generally possessing a highly lamellated structure. Tartar emetic and cream of tartar are among its compounds. "Red" and "white" antimony are used as paints. The electrical relations of this metal are peculiar, and with bismuth it is used in the formation of thermo-electric piles, very like lead.

32. Zinc (Calamine and other ores). Volatile; a white metal with a shade of blue; brittle. Zinc dissolves with facility in dilute hydrochloric acid, and in sulphuric and other hydrated acids, by substitution for hydrogen. White vitriol is sulphate of zinc. Silicate of zinc is found as a crystalline mineral which has received the name of the electrical oxide of iron, because it acquires, like the tourmalin, a high degree of electrical polarity when heated. Brass is a compound of copper, zinc, and iron.

33. Lead (Galena and other ores). Lead is not the heaviest of the metals; easily oxidised making it dangerous for pipes, &c. Litharge or Massicot is yellow, but after fusion brick-red. Red-lead, another pigment, is used in making glass. Plumbic

carbonate occurs native, and is called *cerusite*. Plumbic chromate is chrome yellow. White lead and sugar of lead are also well-known compounds of this metal.

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34. Zirconium (Zirconia and Jargon, Hyacinth). A black powder very like that of charcoal which assumes under the burnisher the lustre of iron, and is compressed into scales which resemble graphite. It takes fire in air below a red heat, and is very slightly attacked by either alkalies or acids, with the exception of hydrofluoric acid which dissolves it with evolutions of hydrogen. Zirconia is a white earth like alumina in appearance. The "Jargon," a gem of Ceylon, resembles the diamond.

35. Thorium (in mineral like Obsidian, called Thorite, from the coast of the North Sea), like yttrium, it burns in oxygen with a brilliancy which is quite extraordinary. Thorina is considered a protoxide, *and it is superior in density to all the other earths.* Thorium is of an iron grey, and has a metallic lustre. It burns as brilliantly as phosphorus does in oxygen. Thorina is thrown down from solutions of this metal by the caustic alkalies as a hydrate.

36. Yttrium (Gadolinite). The density of the earth yttria is greater than Barytes; it somewhat resembles glucina, yttrium is of a greyish colour; of a scaly texture and brittle. It burns splendidly in air, and still more so in oxygen. It combines with sulphur, selenium, &c.

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37. Molybdenum (from its Bisulphuret). A brittle white metal; its ores resemble plumago, for which it was mistaken. It combines in three porportions with oxygen.

38. Vanadium (a rare metal procured from the Slag of Iron ore.) It has a considerable resemblance to chromium in its properties. It combines with oxygen in three proportions. It resembles

molybendum in appearance and has a strong and metallic lustre. Vanadic and chromic acids are the only acids of which the solutions are red; the vanadic becomes blue and the chromic green when deoxidised.

39. Ruthenium (it is obtained from Platinum ores). A white metal.

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40. Cerium (Cerite and Alcanite). White and brittle, or a dark chocolate brown mass with a grey metallic trace; it oxidates quickly in water.

41. Terbium. It is the principal ingredient in the second precipitate obtained from yttria.

42. Erbium has not been obtained in a metallic state.

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43. Lantanum exists in cerite and was confounded with cerium. The salts of lantanum have generally a rose tint and an astringent taste.

44. Tantalum or columbium (obtained from a rare black mineral from North America). It is obtained by a similar process to that used for procuring silicon, *which it very much resembles.* It is a black powder which assumes an iron grey metallic lustre when burnished. As tantalic acid, tantalum exists in most of its minerals, combined with the oxides of iron and manganese or with yttria. It presents itself as a white powder which reddens litmus paper. Sulphotantalic acid forms a grey pulverulent matter, having much the appearance of plumbago; in fact its relationships are with carbon, silicon, and iron. It is a good conductor of electricity.

45. Uranium (Pitchblende). A whitish iron metal. It is very combustible, and when in contact with acids decomposes water, hydrogen being evolved. Pitchblende is an oxide which corresponds to the Magnetic iron oxide. Its compounds are used

in staining porcelain and glass, a very permanent black and a yellowish green tint.

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46. Carbon (Coal, Diamond). Carbon is allotropic. *Graphite or plumbago is its nearest approach to the metallic state.* It appears in crystalline six sided plates of a dark colour. The diamond is an octohedral crystal of carbon. Charcoal and lampblack are considered to be pure carbon also, but like "plantinum black" they may be supposed to be a peculiar form of the element carbon, which as yet has never been obtained in the metallic state, so that iron and plantinum are its nearest congeners. With oxygen it forms the noxious gas carbonic acid, the product of combustion which condensed forms *soot*. With hydrogen it forms the hydrocarbons, *marsh gas* or *fire damp*, *coal gas*, *tar*, *turpentine*, *creosote*, *æther*, *alcohol*, *sugar*, &c. With nitrogen it forms cyanogen gas, these, with some additions, are the elements of *prussic acid*, *prussian blue*, and *the aniline dyes*. With iron it forms steel, and indeed iron is generally found combined with it.

47. Silicon (Sand, Glass, Quartz, &c.) Silicon is dimorphous, *hexagonal and octohedral*. Amorphous silicon can be altered into the form of *lustrous hexagonal scales*, which is the nearest approach yet obtained. *Diamond silicon* forms brilliant octahedral crystals, which are hard enough to scratch glass. *Quartz sand, &c., are oxides of silicon. Much of the crystalline quartz in nature, besides all the agates, calcedonies, and siliceous petrifications, have been formed from aqueous solution* (Graham). It is impossible to obtain alkaline silicates, which are certainly definite combinations, by artificial means (by fusion), as the silicia and silicates of such mixtures do not crystallize separately, but uniformly solidify together on cooling, as a homogeneous glass, whatever their proportions may be, natural silicates have definite proportions and are crystalline.

48. Boron (Borax). A greenish brown solid; acts as a flux for other elements; it is in some respects like lime. It appears

as a dark brown amorphous powder, insoluble in water, and otherwise resembling lamp-black; *also as dark scales like graphite*: and as crystals (white) which are almost as hard as diamond.

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49. Iron (native and in Meteoric Stones, &c.). Pure iron has, when polished, a white colour and brilliant lustre. It is comparatively soft and the most tenacious of all the metals. It is not a good conductor of heat or electricity. Its magnetic powers distinguish it. *Iron oxide is the loadstone and is found native.* The loadstone loses its polarity just below visible ignition. Prussian blue, and other fine colouring matters are composed of salts of iron, &c. Decomposes water at a red heat.

50. Manganese (Rhodonite). A greyish white metal having the appearance of hard cast iron; in water it occasions a disengagement of hydrogen gas; although so like iron its magnetic properties are doubtful. It oxidates readily in the air and falls down as a black powder. Its salts are rose-coloured; they are used in colouring glass. The Amethyst and other gems are also coloured by it. Its isomorphous relations with the magnesian metals, and with sulphur selenium, and tellurium are remarkable.

51. Titanium (Rutile and Ilmenite). The oxide of titanium is obtained in the moist way in the form of a deep purple powder. Ilmenite and other varieties of titanite of iron are isomorphous with peroxide of iron. Titanic acid is a white powder which acquires a yellow tint by a high temperature; *it is considerably analogous in properties to silica*; *like that acid it has a soluble modification.* In some states titanium assumes a deep purple colour, and forms a powder which in the solid form is of a bright copper colour. Titanic acid can be thrown down as a gelatinous precipitate.

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52. Tin, Stannum is its older name (native), next to silver

the whitest of the metals. It is very malleable and is rolled into thin sheets for tin-foil. It is only slightly tarnished by exposure to the air, and not easily affected by acids. *Tin like silicon seems to form a variety of hydrates, probably in consequence of the high atomicity of the elements.* A gelatinous precipitate of stannic salt is analogous to silicic hydrate; the latter is used by dyers as a mordant.

53. Cadmium (Cadmiferous Blende). A white metal like tin; very ductile and malleable. It fuses under red heat and as nearly as volatile as mercury. Nitric acid is its proper solvent. Oxide of cadmium is obtained by the combustion of the metal, as a powder of an orange colour, or as a white hydrate by precipitation from its salts by an alkali. Its salts are white and resemble zinc.

54. Nickel (with Iron and Cobalt, in ores, and also in Meteoric Stones). Like cobalt it is deceptive to miners and is hence called *cupfer-nickle*, or false copper. It is silver white; unalterable in air, and ductile. It is nearly as magnetic as iron. Magnets composed of this metal lose their polarity at 630° (Faraday). It is somewhat more fusible than iron. The solutions of its salts have all a green colour. German silver is formed by fusing together 100 parts of copper, 60 of zinc, and 40 of nickel. Nickel and cobalt have the same atomic weight, and their reactions are so similar that there is great difficulty in separating them from each other.

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55. Copper (various ores). With the exception of titanium copper is the only metal of a red colour. It is more fusible than gold. Sulphate and nitrate of copper are blue salts (blue vitriol and blue nitrate). Acetate of copper is a bright green salt, commonly called verdigris. It has not much affinity for hydrogen.

56. Tungsten (Wolfram, Heavy Stone). The metal when fused has the colour and lustre of iron. It is after gold and

platinum the densest of the metals. It is less fusible than manganese and is not altered in air. Tungstic oxide takes the form of brilliant copper-coloured crystalline plates, A compound of tungstic oxide and soda of a very singular nature was discovered by Wöhler. It forms golden yellow scales and regular cubes possessing the metallic lustre and a striking resemblance to gold. It is insoluble in alkalies or in acids, including even aqua-regia that dissolves gold itself, and is acted upon only by hydrofluoric acid.

57. Donarium obtained as a black powder assumes a metallic lustre when burnished; forms an oxide resembling the earthy bodies.

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58. Gold (native). The only yellow metal, calcium and strontium have only a yellow tinge. Gold has a very high specific gravity, in fact it is heavier than lead. It is an excellent conductor of heat and electricity. It is very soft and exceedingly malleable and ductile. It can be beaten so thin that it will transmit the green rays of light. Gold melts at about the same temperature as copper. *Gold is not acted upon by oxygen or sulphur at any temperature*; nor is it dissolved by any of the ordinary acids. Chlorine gas acts upon it readily; and auric chloride is the only important salt of gold, and stains the skin purple. Fulminating gold contains ammonia.

59. Platinum (found in alloys or other metals). A white metal so difficult to fuse that spongy platinum is its common form. This substance is a grey loosely coherent mass, the properties of which are most extraordinary. In a still finer state it is called platinum black, resembles charcoal and has many similar properties. Platinum black will absorb 250 times its bulk of hydrogen; it is supposed that the gas must be retained by a force equivalent to enormous pressure, and may possibly be in a liquid state. Platinum is the densest body known; it is malleable and ductile, and it is not acted on by any single acid.

Platinum black absorbs and condenses gases in its pores with the evolution of heat. Aqua-regia dissolves it.

60. Palladium (ores of Platinum). This metal has more affinity for oxygen than platinum. In colour it resembles platinum, *but is of a duller white and harder*. It is more fusible than platinum: it is soluble in nitric acid and aqua-regia. Its oxides form beautiful red-coloured salts. When a strip of palladium is made the negative electrode in decomposing water, the palladium absorbs 800 or 900 times its volume of *hydrogen*, expanding perceptibly during the absorption. This "occluded" gas is again given off when the substance (which Professor Graham believed to be an *actual alloy of palladium and hydrogen*) is heated to redness. Palladium appears to have a greater affinity for cyanogen gas than any other metal. Ammoniacal cyanide of palladium forms a precipitate of *brilliant, colourless, crystalline* plates (like diamond).

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61. Chromium (Chromate of Lead), A greyish white metal, fusible with the greatest difficulty, *and not magnetic*. Its salts have a sweet taste and are poisonous. Like iron its compounds with potassium, chlorine, &c., are of splendid colours. Chrome alum is analogous to common alum.

62. Rhodium (in the ore of Platinum). A white metal; brittle and very hard, and may be reduced to powder. The solutions of rhodium have a beautiful red colour, hence its name from "Rose." It appears to have two oxides. It is the most easily oxidised of the metals found in platinum ores.

63. Iridium (from ores of Platinum). It is a very brittle metal, susceptible, when carefully burnished, of considerable polish. It is very difficult of fusion. It is oxidised at a red heat, but only when finely divided. Its name denotes that its compounds exhibit all the colours of the rainbow. It appears to have four degrees of oxidation, and it is the rapid transition of these oxides into each other that occasions the variable tints of

iridium. An alloy of iridium with platinum, *extremely hard*, is used for pen points.

64. Pelopium (in combination with Tantalum and Niobium). Little known.

65. Niobium (Bavarian Tantalite). Niobate of Soda is distinguished from tantalate of soda by being soluble. Little known.

66. Didymium (with Cerium). Its salts are of a rose colour.

Ilmenium is supposed to be associated, as a metallic acid, with niobium and pelopium.

Gallium called after Gaul or France. Crystalline form octohedral, when fused it has a silver lustre, but in solidifying it shows a tinge of blue, losing its brilliancy. It is hardly acted on by nitric acid when diluted with an equal bulk of water.

Samarium, Holmium, Thullium, and Gallium are newly discovered.

P.S.—Fluorine has been insulated and proved to be the most active of all elements. Helium is an imaginary element of the sun. M. B. A.

(Collated from Graham, Roscoe, Armstrong, &c.)

[It is strange that Lockyer does not see that Elementary Gases coming in contact in space *inflame each other, with explosion*, PROBABLY GIVING RISE TO SOLIDS AND LIQUIDS.]

GROUPS.

1.	2.	3.
1. Hydrogen.	4. Fluorine.	7. Bromine.
2. Oxygen.	5. Chlorine.	8. Phosphorus.
3. Nitrogen.	6. Iodine.	9. Sulphur.
4.	5.	6.
10. Selenium.	13. Cæsium.	16. Potassium.
11. Tellurium.	14. Rubidium.	17. Sodium.
12. Thallium.	15. Indium.	18. Barium.
7.	8.	9.
19. Calcium.	22. Magnesium.	25. Mercury.
20. Strontium.	23. Aluminum.	26. Silver.
21. Lithium.	24. Glucinum, or Berylium.	27. Cobalt.
10.	11.	12.
28. Arsenic.	31. Antimony.	34. Zirconium.
29. Osmium.	32. Zinc.	35. Thorium.
30. Bismuth.	33. Lead.	36. Yttrium.
13.	14.	15.
37. Molybdenum.	40. Cerium.	43. Lantanum.
38. Vanadium.	41. Terbium.	44. Tantalum.
39. Ruthenium.	42. Erbium.	45. Uranium.
16.	17.	18.
46. Carbon.	49. Iron.	52. Tin.
47. Silicon.	50. Manganese.	53. Cadmium.
48. Boron.	51. Titanium.	54. Nickel.
19.	20.	21.
55. Copper.	58. Gold.	61. Chromium.
56. Tungsten.	59. Platinum.	62. Rhodium.
57. Donarium.	60. Palladium.	63. Iridium.
22.		
64. Pelopium.	67. Norwegium.	70. Holmium.
65. Niobium.	68. Ilmenium.	71. Samarium.
66. Didymium.	69. Thullium.	72. Gallium.